DIETARY REFERENCE INTAKES

FOR

Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids

Panel on Macronutrients, Panel on the Definition of Dietary Fiber, Subcommittee on Upper Reference Levels of Nutrients, Subcommittee on Interpretation and Uses of Dietary Reference Intakes, and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes

Food and Nutrition Board

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Willing is not enough; we must do."
—Goethe

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PANEL ON DIETARY REFERENCE INTAKES FOR MACRONUTRIENTS

JOANNE R. LUPTON (*Chair*), Faculty of Nutrition, Texas A&M University, College Station
GEORGE A. BROOKS, Department of Integrative Biology, University of California, Berkeley
NANCY F. BUTTE, Department of Pediatrics, U.S. Department of Agriculture/Agriculture Research Service Children's Nutrition Research Center, Baylor College of Medicine, Houston, Texas
BENJAMIN CABALLERO, Center for Human Nutrition, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland
JEAN PIERRE FLATT, Department of Biochemistry and Molecular Biology, University of Massachusetts Medical Center, Worcester
SUSAN K. FRIED, Department of Nutritional Sciences, Rutgers University, New Brunswick, New Jersey
PETER J. GARLICK, Department of Surgery, State University of New York at Stony Brook
SCOTT M. GRUNDY, Center for Human Nutrition, University of Texas Southwestern Medical Center, Dallas
SHEILA M. INNIS, BC Research Institute for Children's and Women's Health, University of British Columbia, Vancouver
DAVID J.A. JENKINS, Department of Nutritional Sciences, University of Toronto, Ontario
RACHEL K. JOHNSON, Department of Nutrition and Food Sciences, University of Vermont, Burlington
RONALD M. KRAUSS, Department of Molecular Medicine, Lawrence Berkeley National Laboratory, University of California, Berkeley
PENNY KRIS-ETHERTON, Department of Nutrition, Pennsylvania State University, University Park
ALICE H. LICHTENSTEIN, Jean Mayer U.S. Department of Agriculture Human Nutrition Research Center on Aging, Tufts University, Boston, Massachusetts
FRANK Q. NUTTALL, Department of Medicine, University of Minnesota School of Medicine, Minneapolis
PAUL B. PENCHARZ, Departments of Pediatrics and Nutritional Sciences, University of Toronto, Ontario
F. XAVIER PI-SUNYER, Department of Medicine, Columbia University, New York
WILLIAM M. RAND, Department of Family Medicine and Community Health, Tufts University School of Medicine, Boston, Massachusetts
PETER J. REEDS (*deceased*), Department of Animal Sciences, University of Illinois at Urbana-Champaign
ERIC B. RIMM, Department of Nutrition, Harvard School of Public Health, Boston, Massachusetts
SUSAN B. ROBERTS, Jean Mayer U.S. Department of Agriculture Human Nutrition Research Center on Aging, Tufts University, Boston, Massachusetts

Staff

PAULA R. TRUMBO, Study Director
SANDRA SCHLICKER, Senior Program Officer
ALICE L. VOROSMARTI, Research Associate
KIMBERLY STITZEL, Research Assistant (until January 2001)
CARRIE L. HOLLOWAY, Research Assistant
GAIL E. SPEARS, Staff Editor
SANDRA AMAMOO-KAKRA, Senior Project Assistant
MICHELE RAMSEY, Senior Project Assistant (until June 2001)

PANEL ON THE DEFINITION OF DIETARY FIBER

JOANNE R. LUPTON (*Chair*), Faculty of Nutrition, Texas A&M University, College Station
GEORGE C. FAHEY, Department of Animal Sciences, University of Illinois at Urbana-Champaign
DAVID J.A. JENKINS, Department of Nutritional Sciences, University of Toronto, Ontario
JUDITH A. MARLETT, Department of Nutritional Science, University of Wisconsin-Madison
JOANNE L. SLAVIN, Department of Food Science and Nutrition, University of Minnesota, St. Paul
JON A. STORY, Department of Foods and Nutrition, Purdue University, West Lafayette, Indiana
CHRISTINE L. WILLIAMS, Department of Pediatrics, Columbia University, New York

Consultants

LEON PROSKY, Prosky Associates, Rockville, Maryland
ALISON STEPHEN, CanTox, Inc., Mississauga, Ontario

Staff

PAULA R. TRUMBO, Study Director
ALICE L. VOROSMARTI, Research Associate
KIMBERLY STITZEL, Research Assistant (until January 2001)
CARRIE L. HOLLOWAY, Research Assistant
GAIL E. SPEARS, Staff Editor
SANDRA AMAMOO-KAKRA, Senior Project Assistant
MICHELE RAMSEY, Senior Project Assistant (until June 2001)

SUBCOMMITTEE ON UPPER REFERENCE LEVELS OF NUTRIENTS

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JOSEPH V. RODRICKS (*Chair beginning January 2002*), ENVIRON International Corporation, Arlington, Virginia
G. HARVEY ANDERSON, Department of Nutritional Sciences, University of Toronto, Ontario
GEORGE C. BECKING, Phoenix OHC, Kingston, Ontario
ELAINE FAUSTMAN, Department of Environmental Health, University of Washington, Seattle
SUZANNE HENDRICH, Department of Food Science and Human Nutrition, Iowa State University, Ames
SANFORD A. MILLER, Center for Food and Nutrition Policy, Virginia Polytechnic Institute and State University, Alexandria
HARRIS PASTIDES, School of Public Health, University of South Carolina, Columbia
JOHN A. THOMAS, San Antonio, Texas
GARY M. WILLIAMS, Department of Environmental Pathology and Toxicology, New York Medical College, Valhalla, New York

Staff

SANDRA SCHLICKER, Study Director
SANDRA AMAMOO-KAKRA, Senior Project Assistant

SUBCOMMITTEE ON INTERPRETATION AND USES OF DIETARY REFERENCE INTAKES

SUSAN I. BARR (*Chair*), Department of Food, Nutrition, and Health, University of British Columbia, Vancouver
TANYA D. AGURS-COLLINS, Department of Oncology, Howard University Cancer Center, Washington, D.C.
ALICIA CARRIQUIRY, Department of Statistics, Iowa State University, Ames
ANN M. COULSTON, Hattner/Coulston Nutrition Associates, LLC., Palo Alto, California
BARBARA L. DEVANEY, Mathematica Policy Research, Princeton, New Jersey
JANET HUNT, U.S. Department of Agriculture/Agriculture Research Service, Grand Forks Human Nutrition Research Center, Grand Forks, North Dakota
SUZANNE MURPHY, Cancer Research Center of Hawaii, University of Hawaii, Honolulu
VALERIE TARASUK, Department of Nutritional Sciences, University of Toronto, Ontario

Staff

MARY POOS, Study Director
ALICE L. VOROSMARTI, Research Associate
HARLEEN SETHI, Project Assistant

STANDING COMMITTEE ON THE SCIENTIFIC EVALUATION OF DIETARY REFERENCE INTAKES

VERNON R. YOUNG (*Chair through April 2002*), Laboratory of Human Nutrition, School of Science, Massachusetts Institute of Technology, Cambridge

JOHN W. ERDMAN, JR. (*Vice-Chair*), Department of Food Science and Human Nutrition, College of Agricultural, Consumer and Environmental Sciences, University of Illinois at Urbana-Champaign

LINDSAY H. ALLEN, Department of Nutrition, University of California, Davis

STEPHANIE A. ATKINSON, Department of Pediatrics, Faculty of Health Sciences, McMaster University, Hamilton, Ontario

JOHN D. FERNSTROM, UMPC Health System Weight Management Center, University of Pittsburgh School of Medicine, Pennsylvania

SCOTT M. GRUNDY, Center for Human Nutrition, University of Texas Southwestern Medical Center at Dallas

SANFORD A. MILLER, Center for Food and Nutrition Policy, Virginia Polytechnic Institute and State University, Alexandria

WILLIAM M. RAND, Department of Family Medicine and Community Health, Tufts University School of Medicine, Boston, Massachusetts

ROBERT M. RUSSELL, Jean Mayer U.S. Department of Agriculture Research Center on Aging, Tufts University, Boston, Massachusetts

Technical Advisor to the DRI Projects

GEORGE BEATON, GHB Consulting, Willowdale, Ontario

U.S. Government Liaison

KATHRYN Y. McMURRY, Office of Disease Prevention and Health Promotion, U.S. Department of Health and Human Services, Washington, D.C.

Canadian Government Liaison

PETER W.F. FISCHER, Nutrition Research Division, Health Protection Branch, Health Canada, Ottawa, Ontario

Staff

ALLISON A. YATES, Study Director
MARY POOS, Senior Program Officer
SANDRA SCHLICKER, Senior Program Officer
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Dedication

The Panel on Macronutrients dedicates this report to the late Peter Reeds, a diligent and enthusiastic member of the panel who made significant contributions to this study. His expertise in protein and amino acid metabolism was a special asset to the panel's work, as well as a contribution to the understanding of protein and amino acid requirements.

Preface

This report is one in a series that presents a comprehensive set of reference values for nutrient intakes for healthy U.S. and Canadian individuals and populations. It is a product of the Food and Nutrition Board of the Institute of Medicine (IOM), working in cooperation with Canadian scientists.

The report establishes a set of reference values for dietary energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids to expand and replace previously published Recommended Dietary Allowances (RDAs) and Recommended Nutrient Intakes (RNIs) for the United States and Canada, respectively. Close attention was given throughout the report to the evidence relating macronutrient intakes to risk reduction of chronic disease and to amounts needed to maintain health. Thus, the report includes guidelines for partitioning energy sources (Acceptable Macronutrient Distribution Ranges) compatible with decreasing risks of various chronic diseases. It also provides a definition for dietary fiber.

The groups responsible for developing this report, the Panel on Macronutrients, the Panel on the Definition of Dietary Fiber, the Subcommittee on Upper Reference Levels of Nutrients (UL Subcommittee), the Subcommittee on Interpretation and Uses of Dietary Reference Intakes (Uses Subcommittee), and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes (DRI Committee), have analyzed the evidence on risks and beneficial effects of nutrients and other food components included in this review.

Although all reference values are based on data, available data were often sparse or drawn from studies with significant limitations in address-

ing various questions confronted by the panel and subcommittees. Thus, although governed by scientific rationales, informed judgments were often required in setting reference values. The reasoning used for each nutrient is described in Chapters 5 through 11. Chapter 13 addresses major conceptual issues related to the uses of the DRIs that were included in the early stages of the DRI process and have been developed further by the Uses Subcommittee.

The quality and quantity of information on overt deficiency diseases for protein, amino acids, and essential fatty acids available to the committee were substantial. Unfortunately, information regarding other nutrients for which their primary dietary importance relates to their roles as energy sources was limited most often to alterations in chronic disease biomarkers that follow dietary manipulations of energy sources.

Given the uniqueness of the nutrients considered in this report (i.e., they or their precursors serve as energy sources and, for this purpose, can substitute for each other in the diet), the inability to determine an Estimated Average Requirement (EAR) or a Tolerable Upper Intake Level (UL) in many cases is not surprising. Also, for most of the nutrients in this report (with a notable exception of protein and some amino acids), there is no direct information that permits estimating the amounts required by children, adolescents, the elderly, or pregnant and lactating women. Similarly, data were exceptionally sparse for setting ULs for the macronutrients. Dose–response studies were either not available or were suggestive of very low intake levels that could result in inadequate intakes of other nutrients. These information gaps and inconsistencies often precluded setting reliable estimates of upper intake levels that can be ingested safely.

The report's attention to energy would be incomplete without its substantial review of the role of daily physical activity in achieving and sustaining fitness and optimal health (Chapter 12). The report provides recommended levels of energy expenditure that are considered most compatible with minimizing risks of several chronic diseases and provides guidance for achieving recommended levels of energy expenditure. Inclusion of these recommendations avoids the tacit false assumption that light sedentary activity is the expected norm in the United States and Canada.

Readers are urged to recognize that the Dietary Reference Intakes (DRI) process is iterative in character. The Food and Nutrition Board and the DRI Committee and its subcommittees and panels fully expect that the DRI conceptual framework will evolve and be improved as novel information becomes available and is applied to an expanding list of nutrients and other food components. Thus, because the DRI activity is ongoing, comments were solicited widely and received on the published reports of this series. Refinements that resulted from this iterative process were included in the general information regarding approaches used (Chapters 1

through 4) and in the discussion of uses of DRIs (Chapter 13). With more experience, the proposed models for establishing reference intakes of nutrients and other food components that play significant roles in promoting and sustaining health and optimal functioning will be refined. Also, as new information or new methods of analysis are adopted, these reference values undoubtedly will be reassessed.

Many of the questions that were raised about requirements and recommended intakes could not be answered satisfactorily for the reasons given above. Thus, among the panel's major tasks was to outline a research agenda addressing information gaps uncovered in its review (Chapter 14). The research agenda is anticipated to help future policy decisions related to these and future recommendations. This agenda and the critical, comprehensive analyses of available information are intended to assist the private sector, foundations, universities, governmental and international agencies and laboratories, and other institutions in the development of their respective research priorities for the next decade.

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Arne Astrup, The Royal Veterinary and Agricultural University; George Blackburn, Beth Israel Deaconess Medical Center; Elsworth Buskirk, Pennsylvania State University; William Connor, Oregon Health and Science University; John Hathcock, Council for Responsible Nutrition; Satish Kalhan, Case Western Reserve University School of Medicine; Martijn Katan, Wageningen Agricultural University; David Kritchevsky, The Wistar Institute; Shiriki Kumanyika, University of Pennsylvania School of Medicine; William Lands, National Institutes of Health; Geoffrey Livesey, Independent Nutrition Logic; Ross Prentice, Fred Hutchinson Cancer Research Center; Barbara Schneeman, University of California, Davis; Christopher Sempos, State University of New York, Buffalo; Virginia Stallings, Children's Hospital of Philadelphia; Steve Taylor, University of Nebraska; Daniel Tomé, Institut National Agronomique Paris-Grinon; and Walter Willett, Harvard School of Public Health.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by Catherine Ross, Pennsylvania State University and Irwin Rosenberg, Tufts University, appointed by the Institute of Medicine, who were responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

The Food and Nutrition Board gratefully acknowledges the Canadian government's support and Canadian scientists' participation in this initiative. This close collaboration represents a pioneering first step in the harmonization of nutrient reference intakes in North America. A description of the overall DRI project and of the panel's task is given in Appendix B.

The Food and Nutrition Board joins the DRI Committee, the Panel on Macronutrients, the Panel on the Definition of Dietary Fiber, the UL Subcommittee, and the Uses Subcommittee in extending sincere appreciation to the many experts who assisted with this report by giving presentations to the various groups charged with its development, providing written materials, participating in the groups' open discussions, analyzing data, and other means. Many, but far from all, of these individuals are named in Appendix C. Special gratitude is extended to the staff at ENVIRON International Corporation for providing national survey data.

The respective chairs and members of the Panel on Macronutrients and subcommittees performed their work under great time pressures. Their dedication made the report's timely completion possible. All gave their time and hard work willingly and without financial reward; the public and the science and practice of nutrition are among the major beneficiaries of their dedication. The Food and Nutrition Board thanks these individuals, and especially the staff responsible for its development—in particular, Paula Trumbo for coordinating this complex report, and Sandra Schlicker, who served as a program officer for the study. The intellectual and managerial contributions made by these individuals to the report's comprehensiveness and scientific base were critical to fulfilling the project's mandate. Sincere thanks also go to other FNB staff, including Alice Vorosmarti, Kimberly Stitzel, Carrie Holloway, Gail Spears, Sandra Amamoo-Kakra, and Michele Ramsey, all of whom labored over nearly three years of work to complete this document.

And last, but certainly not least, the Food and Nutrition Board wishes to extend special thanks to Sandy Miller, who initially served as chair of the Panel on Macronutrients; Joanne Lupton, who subsequently assumed the role of chair of the panel and continued in that role through the

study's completion; and Vernon Young, who served as chair of the DRI Committee since the inception of the overall DRI activity. Professor Young's dedication to this and earlier DRI activities and his uncompromising standards for scientific rigor are most gratefully acknowledged.

Cutberto Garza
Chair, Food and Nutrition Board

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